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Title of Invention: Flowering promotor comprising 2-alkylthio-4-aminopyrimidine derivatives as effective ingredients

Patent Application No.: 63-88992

Patent Application Date: April 13, 1988

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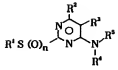
Specifications

1. Title of Invention:

Flowering promotor comprising 2-alkylthio-4-aminopyrimidine derivatives as effective ingredients

2. Claims:

(1) A flowering promotor, characterized in that it contains, as its effective ingredient, 2-alkylthio-4-aminopyrimidine derivatives shown by the general formula



(1)

[wherein R^1 is a C_{1-5} linear or branched alkyl group; n is an integer in the range of 0–2; R^2 is a halogen or an alkyl, alkoxy, alkylthio, or alkylamino group; R^3 is a hydrogen atom, halogen, or a C_{1-3} alkyl, trifluoromethyl, phenyl, benzyl, formyl, hydroxymethyl, or $-CO_2R$ group (wherein R is a hydrogen atom or lower alkyl group); R^4 and R^5 are, independently, hydrogen atoms or C_{1-6} branched or cyclic alkyl, lower alkenyl, $-(CH_2)_mR^6$ (wherein m is an integer in the range of 1–3 and R^6 is a halogen or a nitrile, lower alkoxy, dialkoxymethyl, or phenyl group),  (wherein R^7 is a hydrogen atom or a methyl or chloroalkyl group), or  (wherein R^8 is a hydrogen atom, halogen, or a lower alkyl, lower alkenyl, lower alkoxy, or trifluoromethyl group)].

3. Detailed Explanation of Invention:

Industrial Field of Application

This invention concerns the use of 2-alkylthio-4-aminopyrimidine derivatives, which are useful as flowering promoters.

Prior Art

Plant growth regulators, such as gibberellin, naphthylacetic acid, abscisic acid, benzyladenine, etc., have been known before now. Dwarfing agents for rice, flowering plants, flowering trees, etc., have been used in agriculture, but there are few examples of flowering promoters. For example, it is stated in Japan Public Patent Disclosure Bulletins Nos. 63-5086 and 8304 that triazine derivatives promote the flowering of asparagus.

Problems That the Invention Is to Solve

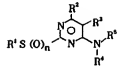
When plant flowering is promoted, the period to harvesting can be shortened, and yields can be increased. Furthermore, in the case of asparagus, etc., they can be used in early selection of male plants, which is beneficial for

agricultural production, and they make increased production and yields possible.

This invention was perfected by performing careful investigations of the novel physiological activity of pyrimidine derivatives, as a result of which it was discovered that they had a powerful activity of promoting flowering, which was wholly unknown until then, and that they are very useful as flowering promoters.

Means of Solving the Problems

The inventors provide a useful flowering promoter which was formerly unknown by utilizing 2-alkylthio-4-aminopyrimidine derivatives shown by the general formula



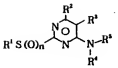
(1)

[wherein R^1 is a C_{1-5} linear or branched alkyl group; n is an integer in the range of 0–2; R^2 is a halogen or an alkyl, alkoxy, alkylthio, or alkylamino group; R^3 is a hydrogen atom, halogen, or a C_{1-3} alkyl, trifluoromethyl, phenyl, benzyl, formyl, hydroxymethyl, or $-CO_2R$ group (wherein R is a hydrogen atom or lower alkyl group); R^4 and R^5 are, independently, hydrogen atoms or C_{1-6} branched or cyclic alkyl, lower alkenyl, $-(CH_2)_mR^6$ (wherein m is an integer in the range of 1–3 and R^6 is a halogen or a nitrile, lower alkoxy, dialkoxymethyl, or phenyl group),  (wherein R^7 is a hydrogen atom or a methyl or chloroalkyl group), or  (wherein R^8 is a hydrogen atom, halogen, or a lower alkyl, lower alkenyl, lower alkoxy, or trifluoromethyl group)].

The compounds shown by Formula (1) are novel ones. They may be produced, for example, by the methods stated in Japan Patent Bulletins Nos. 62-19951, 62-71340, 62-208212, 62-250696, and 62-309587.

Examples of the compounds shown in Formula (1) are shown in Table 1, but the compounds of this invention are not limited to these examples.

Table 1



Compound No.	R^1	R^2	R^3	R^4	R^5	n	m.p. (℃) b.p. (℃/mmHg) or (n_D^{25})
1	CH_3	CH_3	H	H	CH_3=CH−CH_2	0	110−112
2	CH_3	CH_3	H	H	n−C_4H_9	0	(1.5650)
3	CH_3	CH_3	H	C_2H_5	C_2H_5	0	(1.5571)
4	CH_3	CH_3	Cℓ	H	CH_2=$CHCH_2$−	0	(1.5976)
5	CH_3	CH_3	Cℓ	H	n−C_4H_9	0	(1.5704)
6	CH_3	CH_3	Cℓ	C_2H_5	C_2H_5	0	(1.5775)
7	CH_3	CH_3	F	H	H	0	151−153
8	CH_3	CH_3	F	H	CH_3	0	−
9	CH_3	CH_3	F	H	C_2H_5	0	−
10	CH_3	CH_3	F	H	n−C_3H_7	0	94−95

Compound No.	R^1	R^2	R^3	R^4	R^5	n	m.p. (℃) b.p. (℃/mmHg) or (n_D^{25})
11	CH_3	CH_3	F	H	n−C_4H_9	0	77−79
12	CH	CH_3	F	H	i−C_4H_9	0	74−75
13	CH	CH_3	F	H	n−C_4H_9	1	−
14	CH	CH_3	F	H	n−C_4H_9	2	−
15	CH	CH_3	F	H	C_6H_5	0	102−104
16	CH	CH_3	F	H	p−$CH_3C_6H_4$	0	105−107
17	CH	CH_3	F	H	m−FC_6H_4	0	102−104
18	CH	CH_3	F	H	cyclo−C_6H_{11}	0	64−66
19	CH	CH_3	F	C_2H_5	C_2H_5	0	(1.5479)
20	C_2H_5	CH_3	F	H	n−C_3H_7	0	57−60
21	C_2H_5	CH_3	F	H	C_6H_5	0	(1.6312)
22	C_2H_5	CH_3	F	H	p−$CH_3C_6H_4$−	0	66−67
23	C_2H_5	CH_3	F	C_2H_5	C_2H_5	0	(1.5420)

Compound No.	R¹	R²	R³	R⁴	R⁵	n	m.p. (℃) b.p. (℃/mmHg) Or (n_D^{25})
24	i−C_3H_7	CH_3	F	H	p−$CH_3C_6H_4$	0	oil
25	i−C_4H_9	CH_3	F	H	C_2H_5	0	66−68
26	i−C_4H_9	CH_3	F	H	n−C_3H_7	0	71−72
27	i−C_4H_9	CH_3	F	H	CH_2=$CHCH_2$−	0	60−63
28	i−C_4H_9	CH_3	F	H	C_6H_5	0	(1.6052)
29	i−C_4H_9	CH_3	F	H	p−$CH_3C_6H_4$	0	86−88
30	CH_3	CF_3	H	H	n−C_4H_9	0	−
31	CH_3	CF_3	H	H	C_6H_5	0	118−119
32	CH_3	CF_3	H	H	p−$CH_3C_6H_4$	0	138−140
33	CH_3	Cℓ	H	H	C_6H_5	0	115−117
34	CH_3	F	CH_3	H	C_2H_5	0	83−84
35	CH_3	F	CH_3	H	n−C_3H_7	0	114−116
36	CH_3	F	CH_3	H	i−C_3H_7	0	76−78

Compound No.	R¹	R²	R³	R⁴	R⁵	n	m.p. (℃) b.p. (℃/mmHg) Or (n_D^{25})
37	CH_3	F	CH_3	H	CH_2=$CHCH_2$−	0	78−79
38	CH_3	F	CH_3	H	NC−$(CH_2)_2$−	0	160−162
39	CH_3	F	CH_3	H	Cℓ$(CH_2)_2$ −	0	53−55
40	CH_3	F	CH_3	H	n−C_4H_9	0	79−80
41	CH_3	F	CH_3	H	i−C_4H_9	0	111−113
42	CH_3	F	CH_3	H	s−C_4H_9	0	59−60
43	CH_3	F	CH_3	H	t−C_4H_9	0	82−83
44	CH_3	F	CH_3	H	n−C_5H_{11}	0	46−48
45	CH_3	F	CH_3	H	n−C_6H_{13}	0	51−52
46	CH_3	F	CH_3	H	$C_2H_5O(CH_2)_2$−	0	56−58
47	CH_3	F	CH_3	H	$(CH_3)_2N(CH_2)_2$−	0	51−53
48	CH_3	F	CH_3	H	C_6H_5	0	86−88
49	CH_3	F	CH_3	H	p−$CH_3C_6H_4$	0	128−130

Compound No.	R^1	R^2	R^3	R^4	R^5	n	m.p. (℃) b.p. (℃/mmHg) or (n_D^{25})
50	CH_3	F	CH_3	H	p−$CH_3C_6H_4$	1	216−218
51	CH_3	F	CH_3	H	p−$CH_3C_6H_4$	2	213−216
52	CH_3	F	CH_3	H	m−FC_6H_4	0	81−83
53	CH_3	F	CH_3	H	m−ClC_6H_4	0	112−114
54	CH_3	F	CH_3	H	$C_6H_5(CH_2)_2$−	0	105−107
55	CH_3	Cl	CH_3	H	C_6H_5	0	133−135
56	C_2H_5	Cl	CH_3	H	n−C_4H_9	0	95−97
57	C_2H_5	Cl	CH_3	H	C_6H_5	0	85−87
58	C_2H_5	F	CH_3	H	C_6H_5	0	80−82
59	C_2H_5	F	CH_3	H	n−C_5H_7	0	39−41
60	C_2H_5	F	CH_3	H	n−C_4H_9	0	71−73
61	C_2H_5	F	CH_3	H	C_6H_5	0	49−51
62	C_2H_5	F	CH_3	H	p−$CH_3C_6H_4$	0	104−106

Compound No.	R^1	R^2	R^3	R^4	R^5	n	m.p. (℃) b.p. (℃/mmHg) or (n_D^{25})
63	n−C_3H_7	F	CH_3	H	C_6H_5	0	98−100
64	n−C_3H_7	F	CH_3	H	n−C_5H_7	0	63−65
65	n−C_3H_7	F	CH_3	H	n−C_4H_9	0	29−31
66	n−C_3H_7	F	CH_3	H	C_6H_5	0	45−47
67	n−C_3H_7	F	CH_3	H	p−$CH_3C_6H_4$	0	68−70
68	CH_3	F	C_2H_5	H	C_6H_5	0	91−93
69	CH_3	F	C_2H_5	H	p−$CH_3C_6H_4$	0	99−101
70	CH_3	Cl	i−C_3H_7	H	C_6H_5	0	104−106
71	CH_3	Cl	C_2H_5	H	C_6H_5	0	111−113
72	CH_3	F	CF_3	CH_3	CH_3	0	67−69
73	CH_3	F	CF_3	H	n−C_4H_9	0	—
74	CH_3	F	CF_3	H	s−C_4H_9	0	(1.4983)
75	CH_3	F	CF_3	H	C_6H_5	0	81−83

Compound No.	R^1	R^2	R^3	R^4	R^5	n	m.p. (℃) b.p. (℃/mmHg) Or (n_D^{25})
76	CH_3	Cℓ	CF_3	H	CH_3	0	73－75.5
77	CH_3	Cℓ	CF_3	H	C_2H_5	0	48－50
78	CH_3	Cℓ	CF_3	C_2H_5	C_2H_5	0	51.5－53
79	CH_3	Cℓ	CF_3	H	i－C_3H_7	0	125／1.5
80	CH_3	Cℓ	CF_3	H	n－C_4H_9	0	60.5－61.0
81	CH_3	Cℓ	CF_3	H	C_6H_5	0	67.5－70.5
82	CH_3	Cℓ	CF_3	H	C_6H_5	1	124－126
83	CH_3	Cℓ	CF_3	H	C_6H_5	2	153－155
84	CH_3	Cℓ	CF_3	CH_3	C_6H_5	0	72－74
85	C_2H_5	F	CF_3	H	C_6H_5	0	60－62
86	C_2H_5	Cℓ	CF_3	H	C_6H_5	0	76－78
87	i－C_3H_7	Cℓ	CF_3	H	C_6H_5	0	47－49
88	CH_3	Cℓ	CH_2OH	C_2H_5	C_2H_5	0	74－75

Compound No.	R^1	R^2	R^3	R^4	R^5	n	m.p. (℃) b.p. (℃/mmHg) Or (n_D^{25})
89	CH_3	Cℓ	CH_2OH	H	n－C_4H_9	0	101－103
90	CH_3	Cℓ	CH_2OH	H	p－$CH_3C_6H_4$	0	154－156
91	CH_3	Cℓ	$-CH_2O\overset{O}{\overset{\|}{C}}CH_3$	H	p－$CH_3C_6H_4$	0	131－133
92	CH_3	Cℓ	CHO	H	n－C_4H_9	0	49－51
93	CH_3	Cℓ	CHO	H	p－$CH_3C_6H_4$	0	128－130
94	CH_3	CH_3O	CH_3	H	n－C_4H_9	0	(1.5575)
95	CH_3	CH_3O	CF_3	H	n－C_4H_9	0	120／3
96	CH_3	CH_3O	CF_3	C_2H_5	C_2H_5	0	110／3
97	CH_3	C_2H_5NH	CF_3	H	n－C_4H_9	0	138／0.8
98	C_2H_5	CH_3NH	CF_3	H	C_2H_5	0	115／0.6
99	CH_3	C_2H_5NH	CF_3	H	i－C_3H_7	0	100／0.1
100	CH_3	C_2H_5NH	CF_3	H	i－C_4H_9	0	120／0.1
101	CH_3	F	H	H	$CCℓ_3CH(OH)$	0	130－132

The novel compounds which are shown by Formula (1) of this invention, and which are obtained as stated above, have desirable activities on plants. When they are used as plant growth regulators, they are used by diluting them, individually or in mixtures of 2 or more, with water in low concentrations, or by mixing them with agricultural adjuvants which are ordinarily used to produce powders, granules, lozenges, solid forms, wettable agents, emulsions, or solutions, of aqueous, dispersion, flowable, etc., types by using water or other suitable diluents. In this case, one can use, for example, mixtures in the range of 99 parts adjuvants per 1 part of the derivatives of Formula (1) to 10 [*sic*] parts adjuvants to 80 [*sic*] parts of the derivatives of Formula (1).

The quantities of the novel derivatives which may be compounded in the regulators of this invention and the quantities of the regulator which may be applied are not limited; they can be determined as is suitable according to the formulation, the kind of plant on which they are to be applied, the method of application, the time or period of application, etc. However, as a rule, they may ordinarily be used in concentrations of their effective ingredients which are in the range of 1–1000 ppm, preferably 10–500 ppm, when they are prepared in the form of aqueous solutions.

If desired, moreover, the aforementioned plant growth regulators of this invention may be compounded with other growth regulators or fertilizer ingredients, week killers, insecticides, bactericides, etc.

Effectiveness of Invention

The compounds of this invention, shown by Formula (1) above, can be produced efficiently and by simple methods, and these compounds show desirable growth regulating activities on various kinds of plants in the agricultural and horticultural fields. Therefore, they have a high practical value. Next, examples will be given of their activity of promoting the growth and bud formation of plants by treating seeds of plants with the chemical agents. In particular, they are characterized by the fact that they have high degrees of efficacy on plants of the *Liliaceae* family, such as asparagus, and they have very

low toxicities towards plants.

Formulation examples will be shown below, but the kinds and mixture ratios of agricultural adjuvants are not limited to the ones mentioned herein; a wide range of them may be used. Furthermore, "parts" means parts by weight.

Formulation Example 1. Powder

One part of Compound No. 1, 20 parts talc, and 79 parts clay were mixed and pulverized to form a powder.

Formulation Example 2. Wettable agent

Twenty parts of Compound No. 3, 73 parts kaolin, 5 parts sodium higher alcohol sulfate, and 2 parts sodium lignin sulfonate were mixed and pulverized to form a wettable agent.

Formulation Example 3. Granules

1.5 Parts of Compound No. 5, 36 parts diatomaceous earth, 24 parts bentonite, 8.5 parts talc, and [*blank*] parts disintegrating agent were mixed, after which 18 parts water were added and the mixture was uniformly moistened. Next, the mixture was extruded through an injection molder to form granules. The granule sizes were sorted, after which they were dried, and granules with diameters of 0.6–1 mm were made.

Formulation Example 4. Fine granules

One part of Compound No. 6, was uniformly mixed with [*blank*] parts polyvinyl alcohol and 16 parts clay; the mixture was then pulverized to form a concentrated granular product. Separately, 73 parts of a coarse (74–105 microns)

powder of a mineral substance which did not absorb oil were put into a suitable mixer, and [*blank*] parts water were added, while it was made to rotate. The aforementioned concentrated granular product was added, and the granules were coated. The result was dried to form the fine granules.

Formulation Example 5. Emulsion agent

Ten parts of Compound No. 25 were dissolved in 60 parts xylene and 30 parts of a mixture (8:2) of an alkylphenol-ethylene oxide condensate and a calcium alkylbenzenesulfonate were mixed and dissolved to form an emulsion.

This emulsion agent was diluted and used as an emulsion.

Next, the fact that the compounds of this invention have excellent growth regulating activities on various species of agricultural and horticultural plants will be explained by working examples.

Working Example 1

One centimeter of sea sand was spread in each of a number of plastic pots 9 cm in diameter (500 ml volume), and 20 ml of solutions of the compounds being tested, in specific concentrations (these concentrations being formed by preparing 20% wettable agents of the samples and diluting them to the concentrations with water), were put into each pot. Forty asparagus seeds (variety: Merry Washington 500) were planted per pot, and lids were placed on the pots. After the seeds were treated, the plants were grown for 13 days in an artificial atmosphere room with the conditions adjusted beforehand to 20–25°C (switched at 12 hours) and 4000 lux artificial illumination (switched between light and dark every 12 hours). After this, the plants were grown for 13 days in plastic pots 9 cm in diameter (500 ml volume) filled with field soil (volcanic ash soil) and specific quantities of fertilizer. When the seedlings were 1–3 cm long, they were

transplanted at 30 plants per pot. After the transplanting, they were cultivated for 14 days in a heated greenhouse (min. 18°C–max. 26°C). The numbers of buds formed were counted, and the degrees of damage by the chemicals were assessed according to the following standards on the 28th day after the transplantation. Two concentrations of each test compound were used.

Chemical damage standards:

- \- Unharmed
- \+ Very slight damage
- ++ Little damage
- +++ Moderate damage
- ++++ Considerable damage
- X Completely withered

Tables 1 and 2 show the results of the experiment. As shown in Tables 1 and 2, the compounds of this invention showed very high degrees of efficacy, whereas the untreated section (only water used) showed almost no formation of asparagus bugs. Furthermore, damage was produced by the control agents, whereas the plants treated by the compounds of this invention showed almost no damage. Thus, it was found that the compounds of this invention showed high degrees of their characteristic properties.

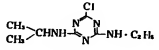
Table 1

Compound No.	Concentration ppm	Number of sprouts per pot	Number of flowers appearing		Chemical damage
			Number of flowers appearing	Flowering rate (%)	
1	10	25.5	3	12	–
	100	21.5	8.5	40	–
2	10	25.5	4.5	18	–
	100	26.0	12.0	46	–
3	10	26.5	4.5	17	–
	100	20.0	16.0	80	–
4	10	26.5	5.5	21	–
	100	25.0	11.0	44	–
5	10	27.0	6.0	22	–
	100	18.0	14.0	78	–
6	10	26	4.0	15	–
	100	23	10.0	43	–
11	10	28	12.0	43	–
	100	25	16.0	64	–
12	10	26	7.0	27	–
	100	26	13.0	50	–
25	10	27	13.0	48	–
	100	27	23.0	85	–
33	10	27.5	8.0	29	–
	100	30.0	15.0	50	–
34	10	28	5.0	18	–
	100	26	16	62	–
35	10	28	4.0	14	–
	100	18	8.0	29	–
36	10	24.5	3.0	12	–
	100	23.0	8.0	35	–
41	10	30	5.0	17	–
	100	27.5	11.0	40	–
42	10	27	6.0	22	–
	100	26	12.0	46	–
43	10	27	8.0	30	–
	100	27.5	20.0	83	–

Table 2

Compound No.	Concentration ppm	Number of sprouts per pot	Number of flowers appearing		Chemical damage
			Number of flowers appearing	Flowering rate (%)	
55	10	26.5	5.0	19	–
	100	26.5	9.0	24	–
63	10	26.0	5.0	19	–
	100	27.5	12.0	24	–
66	10	26.5	8.0	30	–
	100	25.0	10.0	40	–
76	10	25.5	2.0	8	–
	100	26.0	10.0	34	–
77	10	27.0	6.0	22	–
	100	28.0	15.0	54	–
78	10	28.0	5.0	18	–
	100	26.0	10.0	38	–
79	10	26.0	13.0	50	–
	100	13.0	5	38	–
88	10	25.5	5.0	20	–
	100	26.5	8.0	30	–
98	10	30.0	4.0	13	–
	100	28.0	8.0	29	–
101	100	25.0	2.0	8	–
Control agent	10	28	0	0	–
	100	27	5	19	–
Untreated (water) 1	–	28	0	0	–
		27.5	0	0	–
Untreated (water) 2	–	26.5	0	0	–
		26.0	0	0	–

Control agent:



Working Example 2

One hundred milliliters of solutions of the compounds being tested, in specific concentrations were injected into plastic pots 9 mm in diameter (500 ml

volume). Specific quantities of asparagus seeds were immersed in these solutions and they were put into artificial weather boxes adjusted beforehand to 20–25°C (switched at 12 hours) and 4000 lux artificial illumination (switched between light and dark every 12 hours) for 7 days. On the 7th day, the seeds were washed thoroughly with water and planted in plastic pots 18 cm in diameter (1.5 liter volume) containing soil mixed with specific quantities of fertilizer (50 seeds per pot). These pots were placed in a heated glass greenhouse (min. 18°C–max. 26°C) and the number of buds formed after 20 days were counted. The chemical damage was assessed on the 30th day according to the following standards.

Chemical damage standards:

-	Unharmed
+	Very slight damage
++	Little damage
+++	Moderate damage
++++	Considerable damage
X	Completely withered

The results of Working Example 2 are shown in Table 3. As shown in Table 3, the compound of this invention was found to have the same high flower promoting effect as shown in Working Example, and almost no chemical damage.

Table 3

Compound No.	Concentration ppm	Number of sprouts per pot	Number of flowers appearing		Chemical damage
			Number of flowers appearing	Flowering rate (%)	
1	100	48	13	27	–
2	100	42.5	15	35	–
4	100	45.0	25	56	+
5	100	47.5	32	67	–
11	100	47.5	33	69	–
25	100	46	13	28	–
34	100	45	30	67	–
35	100	45.5	12	26	–
43	100	43.5	20	46	–
66	100	46	5	11	–
77	100	46	5	11	–
79	100	44.5	3	7	–
98	100	46.0	3	7	–
Control agent	100	46.5	1	2	++++
Untreated (water) 1	–	47.0	0	0	–
Untreated (water) 2	–	48.5	0	0	–

Control agent: Same as in Working Example 1.

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